both the visual and photographic observations. The Cambridge photographs of June 13 are particularly valuable in having α Cygni as a comparison spectrum, thereby confirming Sir Norman Lockyer's conclusion that many of the enhanced lines which are so prominent in this star are reproduced as bright lines in the spectra of novæ. Later observations communicated to us by Prof. Fowler show that this stage continued up to June 16, when his last observations were made. The bright C and F lines of hydrogen, and the enhanced lines of iron $\lambda\lambda$ 517, 502, and 492, have remained the most conspicuous features of the visible spectrum since bright lines appeared, and the diminishing luminosity of the star has been accompanied by a marked reduction in the intensity of the continuous spectrum.

On June 12 it was found that the bright fringe on the red side of the dark band about λ 589 had become a definite bright band, having a narrow dark line near its red edge, the whole group being probably identical with that shown in photographs of Nova Persei taken at the Yerkes and Lick Observatories, which clearly proved that the narrow line was sodium D. Revised estimates of the two bright lines between C and D suggested identity with lines about λ 615 and λ 625 shown in the Yerkes photographs of Nova Persei, and a fainter line was noted about λ 641. Two vague brightenings were also observed between F and G. On June 13 the dark band about D was much reduced in intensity, while that about λ 560 had become considerably stronger. On June 15 and 16 the principal change was the reduced intensity of the continuous spectrum and the consequent greater clearness of the bright lines between 517 and D. If the nova progresses at the same rate as Nova Persei, the third stage may possibly be entered upon about the end of the first week in July.

With reference to the probable distance of the nova, direct determinations of the parallax will necessarily occupy a considerable time. The circumstance that nearly all novæ have occurred in the Milky Way, however, furnishes strong evidence that these objects are actually situated in the Milky Way, and, therefore, at distances of the order of, say, 3000 light-years.

THE NEW SYSTEM OF TIME-KEEPING AT SEA.

AN article in NATURE for April 25 described the new system of time-keeping at sea which was adopted last year by the British, French, and Italian Admiralties. The Board of Trade has now published a memorandum on the subject, with a coloured chart, adapted from a similar one prepared by the "Service hydrographique de la marine française." Reference may also be made to useful explanatory articles by M. J. Renaud in "Annuaire du Bureau des Longitudes, 1918," and in *L'Astronomie* for April, 1918.

The chart illustrates the international time system both by land and sea. The countries and States that have adopted it are coloured either red or blue, red denoting Greenwich time, or time differing from it by an even number of hours, while blue denotes a difference of an odd number of hours. A few countries (India, South Australia, Venezuela) use time differing from Greenwich time by an odd number of half-hours; these are coloured violet on the chart. The remaining countries are coloured yellow. Inspection of the chart shows what great progress the international time system has already made. The whole of Europe except Russia, almost the whole of Africa, Japan, Australia, North America, Peru, and Brazil have adopted it. It is not improbable that its adoption by ships may lead to still further extension of it on land.

It is much to be regretted that the Board of Trade uses the term "zones" to denote the regions that keep the same time. The use of this term ought to be confined to the designation of belts parallel to the equator, not at right angles to it. It is much better to employ the term "fuseau," which the French have adopted, unless a suitable English name can be devised.

Inspection of the chart shows that the boundaries of the "fuseaux" on land do not strictly follow the theoretical meridians; they frequently deviate to some political boundary not far away, in order to keep the same time throughout a country or State. It is obviously convenient for a ship while in territorial waters to keep the time observed on the adjacent coast; local tide tables, etc., would be given in this time. But when on the high seas it should change its clocks at the nearest convenient moment to the time of entering the new "fuseau" (say, at the nearest change of watch).

It is important to note that the change of system is wholly in the direction of greater simplicity. Hitherto there have been two entirely distinct sets of timepieces on board: the chronometers, used in navigating the ship, which keep Greenwich time; and the ship's clocks, used for the ordinary purposes of daily life; these have usually kept local apparent time, being set about noon on each day, sometimes twice a day if the ship was travelling very rapidly. For the future all clocks on ships in all parts of the world ought to show the same minute as the gate-clock at Greenwich, the difference being in the hours only.

The French and English have adopted different modes of numbering the "fuseaux." Both agree to call the Greenwich "fuseau" (extending from 7½° W. to 7½° E.) zero; the French number the "fuseaux" to the east of this +1, +2, +3, in succession, up to +23 for the "fuseau" just west of the zero one. These numbers give the correction to apply to Greenwich time to obtain ship's time. The English system uses two series of numbers, each from 1 to 12, negative to the east, and positive to the west, thus giving the correction to apply to ship's time to obtain Greenwich time. It matters little which is done, provided the system is understood. It is recommended that the "fuseau"-number be always displayed on the

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ship's clocks, and quoted in all time-readings. Only one ambiguity would remain—that of the Greenwich day. Uncertainty about this might arise in the neighbourhood of the antimeridian of Greenwich; the line of demarcation, which is shown on the chart, is not quite regular, different islands keeping Asiatic or American reckoning according to their political affinities and history.

It was with the view of lessening these difficulties that Commandant Vincent added a day-hand to his chronometer dial (see p. 146). It is clear that the difficulty is considerably increased by the fact that at Greenwich two different systems, the civil and the astronomical, are in use, the day beginning at midnight and noon respectively. It is hoped that the reform of using the former system for all purposes may soon be introduced. From the discussion that is now taking place, it is clear that the only serious difficulty that is felt in the matter is the breach that will be caused in the continuity of astronomical records. This inconvenience will be minimised if in all records, for some years before and after the change, the time-origin employed is clearly stated.

Summer time is not to be used at sea; it would cause needless complication, and the reasons which make it desirable on land are much less potent at sea; it will be remembered that navigation and astronomy were excluded from the scope of the Act, and the Greenwich ball has been dropped throughout at 1 o'clock Greenwich time (2 o'clock summer time). A. C. D. CROMMELIN.

DAMASCENE STEEL.

DAMASCENE or Damascus steel made its appearance in Western Europe during the Middle Ages. It was manufactured in India, and the origin of the process may be traced back many centuries B.C. The same kind of steel had previously been introduced into Russia, where it was known as "poulad" or "bulat." The external characteristic of this steel was its patterned surface-watering or "jauher" (Persian), which gave rise to the name "poulad jauherder." It was imported into Russia through Persia and the Caucasus, and into Western Europe through Syria and Palestine.

A most interesting and important study of this material was presented by Col. N. T. Belaiew at the spring meeting of the Iron and Steel Institute. According to his researches, there were three principal methods of producing it:—

(1) The old Indian, by which crucible steel was made by melting pure ore with the best kind of charcoal; (2) the Persian, in which case pure soft iron and graphite were the ingredients; and (3) a particular heat treatment which was in the nature of a prolonged tempering.

The greatest care was taken in regard to the temperature and duration of the melting process, since it was known that the best "watering" could be obtained only with alloys which were kept molten for a long time and afterwards very gradually cooled. The fluid alloy was allowed to freeze in the crucible, and removed only when cold in the form of a cake.

These cakes have been described by Tavernier and others, and were brought to this country by Scott. Numerous investigations were carried out on them, notably by Stodart and Faraday in England, Réaumur and Bréant in France, and Anossoff in Russia. The last-named was led so early as 1831 to apply the microscope to the study of polished and etched surfaces, not merely of these steels, but also of all his alloys that were intended for industrial applications. He was the first to classify the patterns of damascene blades, and showed that in steels containing the least carbon the watering took the form of parallel stripes, and that as the carbon increased these became wavy, then mottled, and finally passed into vertebræ, which were considered the most perfect form. To this the Persians gave the name "kirk narduban," or "forty steps of Mahomet's ladder."

Col. Belaiew took up the experimental study of these steels at the instigation of Prof. Tchernoff, who, in lecturing at the Michael Artillery Academy, Petrograd, stated that "the best kind of steel ever manufactured was undoubtedly the bulat." He found that the majority of damascene steels contained from 1·1 to 1·8 per cent. of carbon. The following is a complete analysis of one of them:—

C	Mn	Si	S	P
1·49	0·08	0·005	0·05	0·10

He then proceeded to reproduce the steels artificially at the Putiloff works, using the Eastern Crucible method (soft iron and graphite), and studied both the primary crystallisation (from the melt) and the secondary (from the solid), and showed that the latter differed in its form according to whether the steels were hypo- or hyper-eutectoid, *i.e.* < or > 0·90 per cent. of carbon. Damascene steels all belong to the latter category. He found that in all cases where the alloys were slowly cooled a remarkably clear primary and secondary crystallisation followed. The former consisted of dendrites of austenite of very varying carbon content, the latter of dendrites of cementite which closely followed the orientation of the austenite axes. The higher the carbon the more closely did the primary and secondary crystallisations resemble one another, and a "structure of large crystals" resulted. To understand how, from an alloy with this structure, the beautiful wavy or motley watering of Oriental blades can be obtained, he discusses the life-history of a 1·5 per cent. carbon steel from the molten state. Every cake is either cut in two, in which case each half makes the blade of a sabre, or the central part is cut away and the remaining ring is cut through at one place so as to facilitate subsequent working and then drawn into a bar. If the specimen is only drawn lengthwise the "veins" produced are longitudinal and the watering consists of parallel stripes or ronces. But if the forging is executed in two or more directions, then, "according to the skill of the workman and

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